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AD871586

FLEXIBLE ROLLED-UP SOLAR ARRAY

EIGHTH QUARTERLY REPORT

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PREPARED FOR:
Air Force Aero Propulsion Laboratory
Research and Technology Division
Wright-Patterson Air Force Base, Ohio 45433

Attn: APIP-2

PROJECT NO. 682J/DATA NO. HS207-205(8)/CONTRACT NO. F33615-68-C-1676

PREPARED BY:
Hughes Aircraft Company / Space Systems Division
(Under Contract F33615-68-C-1676)

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JUL 15 1970
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AUTHORS: E. O. Felkel
G. Wolff
Et al.

Hughes Ref No. 70(22)-7804 / B5532-012

SSD 00332R

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FOREWORD

This report was prepared by Hughes Aircraft Company, Space Systems Division, El Segundo, California, under Contract F33615-68-C-1676. The work was administered under the direction of L. D. Massie, APIP-2, Air Force Aero Propulsion Laboratory.

The period covered extends from 30 March 1970 to 28 June 1970. Contributors to this report include E. O. Felkel, G. Wolff, M. C. Olson, W. N. Turner, R. E. Daniel, G. P. Steffen, D. Plummer, R. K. Geiser, D. Garth, C. Duncan, and D. Lane, all of Hughes Aircraft Company, Space Systems Division, El Segundo, California.

The work covered herein was accomplished under Air Force Contract F33615-68-C-1676, but this report is being published and distributed prior to Air Force review. Publication of this quarterly, therefore, does not constitute approval by the Air Force of the findings or conclusions contained herein. It is published for the exchange and stimulation of ideas.

ABSTRACT

The main activities on the Flexible Rolled-Up Solar Array (FRUSA) during the eighth quarterly reporting period consisted of completion of detail parts and start of assembly of the development/qualification model orientation mechanism and solar array.

The panel substrate and bus assembly is nearing completion and solar cell bonding will begin the second week in July. Assembly of some of the orientation mechanism subassemblies has been completed, and the assembly should be complete by 1 August. Fabrication of the control electronics unit, solar cell electronics unit, and instrumentation conditioning unit has been completed. However, the late delivery of some high reliability components has necessitated the utilization of a few functionally equivalent commercial components so that acceptance testing of the units could be started. The commercial components will be replaced with the high reliability parts when they become available and, in any event, prior to environmental testing. Schematics and detail and assembly drawings of the battery/charge controller and power conditioning units have been completed. Schematics of the load bank have been completed. Detail design is nearing completion. Release of drawings of all three units is scheduled for mid-July. Procurement of high reliability parts for the units has been initiated.

Several working group meetings were held between SAMSO/Aerospace/LMSC and Hughes to resolve interface problems, the most serious of which seems to be the shading of the FRUSA panels by the LMSC rigid array. The change directed by the customer to provide full live-cell panel coverage and to incorporate a position encoder, furnished by LMSC, on the orientation mechanism support axis has been implemented in the design.

The FRUSA/Agena wiring diagram was completed and released. The Technical Plan was updated and submitted to WPAFB .

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ILLUSTRATIONS

TABLE

SECTION I

INTRODUCTION AND SUMMARY

This document reports progress in the eighth quarter (30 March to 28 June 1970) on AFAPL contract F33615-68-C-1676, Flexible Rolled-Up Solar Array, Project Number 682J.

The main activities on the Flexible Rolled-Up Solar Array (FRUSA) during the eighth quarterly reporting period consisted of completion of detail parts and start of assembly of the development/qualification model orientation mechanism and solar array.

The panel substrate and bus assembly is nearing completion and solar cell bonding will begin the second week in July. Assembly of some of the orientation mechanism subassemblies has been completed, and the assembly should be complete by 1 August. Fabrication of the control electronics unit, solar cell electronics unit, and instrumentation conditioning unit has been completed. However, late delivery of some high reliability components has necessitated use of a few functionally equivalent commercial components so that acceptance testing of the units could be started. The commercial components will be replaced with the high reliability parts when they become available and, in any event, prior to environmental testing. Schematics and detail and assembly drawings of the battery/charge controller and power conditioning units have been completed. Schematics of the load bank have been completed. Detail design is nearing completion. It is planned that the drawings of all three units will be released by mid-July. Procurement of high reliability parts for the units has been initiated.

A number of working group meetings were held between SAMSO/Aerospace/LMSC and Hughes to resolve interface problems, the most serious of which seems to be the shading of the FRUSA panels by the LMSC rigid array. The change directed by the customer to provide full live-cell panel coverage and to incorporate a position encoder, furnished by LMSC, on the orientation mechanism support axis has been implemented in the design.

The FRUSA/Agena wiring diagram was completed and released. The Technical Plan was updated and submitted to WPAFB.

The format of this quarterly report is designed to present the status of each major system element in a separate section.

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SECTION II

PROGRAM STATUS

The Flexible Rolled-Up Solar Array (FRUSA) program is divided into five phases, as described in the paragraphs that follow. The current program schedule and status are shown in Figure 1.

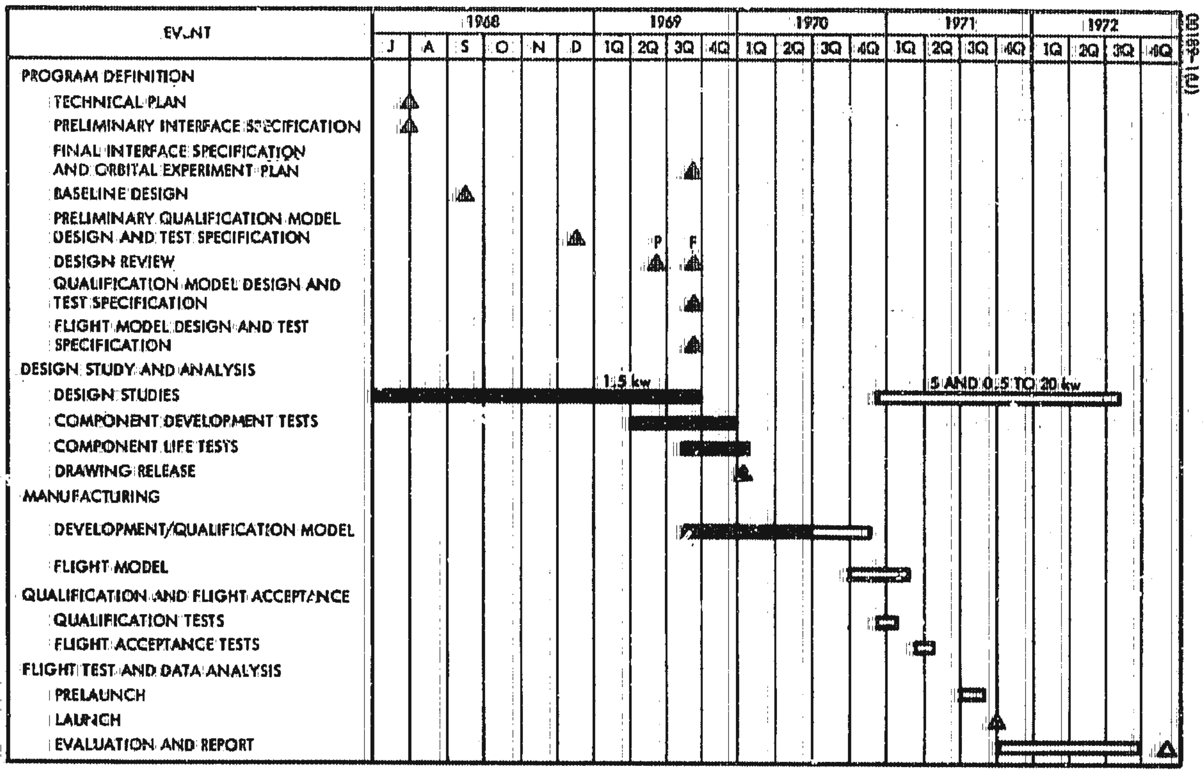

Figure 1. Program Schedule

PHASE I – PROGRAM DEFINITION

Major milestones associated with this phase and scheduled during this period have been completed. Included in this category are all the program requirements, design, and test requirements.

PHASE II – DESIGN STUDY AND ANALYSIS

The study phase of the program has been completed and a firm baseline design established. Design packaging details have been completed except for the power conditioning subsystem which will be completed during the next quarter. The formal test plan has been established and released.

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PHASE III – MODEL FABRICATION

All engineering drawings have been released with the exception of the power conditioning subsystem which will be released in July. Fabrication of the engineering/qualification model is proceeding. About 95 percent of the piece parts have been received, with the balance due by 10 July 1970. Assembly operations on the panel and orientation mechanism are progressing satisfactorily. The directed change to provide full live-cell panel coverage is proceeding as planned. Numerous Air Force/Aerospace/Hughes/LMSC working group meetings to resolve interface problems have been held and more are scheduled during the next reporting period.

PHASE IV – QUALIFICATION AND FLIGHT ACCEPTANCE TESTS

Qualification and flight acceptance tests will be conducted according to the test plan.

PHASE V – FLIGHT TEST AND DATA ANALYSIS

The flight test and data analysis phase will include prelaunch check-out and countdown procedures as well as in-orbit operation and analysis.

SECTION III

SYSTEM ENGINEERING

INTERFACE MEETINGS

A joint SAMSO/Aerospace/LMSC/Hughes meeting was held at Hughes on 16 April 1970. The purpose of the meeting was to discuss the FRUSA/Agena interfaces and to update the RTD-806 experiment requirements. The orientation mechanism thermal parameters were updated based on Hughes providing full live-cell coverage on the panels. In addition, a test plan and the characteristics of the support axis tachometer output were prepared. The above-mentioned items were submitted by letter to WPAFB, SAMSO, Aerospace, and LMSC on 29 April. At the same meeting, Hughes requested the dynamics and thermal requirements imposed on the FRUSA system during launch, as well as the thermal model of the Agena equipment rack. The above-mentioned data have not yet been received.

A large number of telephone conversations were held following the meeting to discuss interface problems. The most serious problems encountered were those dealing with shadowing between the FRUSA and the LMSC arrays and interference between the FRUSA array and the Agena telemetry and tracking antennas.

On 14 May 1970, an Interface Working Group (IWG) meeting was held at LMSC and the following action items were assigned to Hughes for response:

HR-3	Redefine requirement for solar array tiedown at Agena interface
HR-4	Provide LMSC with a breakdown of FRUSA mass properties data
HR-5	Provide time-torque plots for normal and emergency modes
HR-6	Provide FRUSA dynamic loads ascent analysis
HR-7	Provide telemetry response to each command function
HR-8	Provide command and telemetry system schematics
HR-9	Provide scale factors and range of all telemetry signals
HR-10	Examine two LMSC approaches for FRUSA position indicator and give LMSC a preference
HR-11	Determine acceptance of stopping array slewing during eclipse

HR-12 Assess the shading effects of Agena solar array on FRUSA

HR-13 Provide maximum and minimum static friction on support axis

HR-14 Provide information on conductive interference by FRUSA on Agena power bus

On 22 May 1970, a meeting was held at LMSC in Sunnyvale, California, to discuss FRUSA command and telemetry responses and to deliver responses to action items resulting from the IWG meeting of 14 May 1970. Hughes agreed to eliminate three commands from the load bank switching. In place of the four load bank off-commands, one command will turn off all loads.

Another meeting was held at SAMSO on 27 May 1970 with L. D. Massie of WPAFB, representatives of the SAMSO-SESP Program Office, Aerospace, LMSC, and Hughes. All of the above-listed action items were closed with the exception of HR-6, HR-12, and HR-14. A FRUSA dynamic loads ascent analysis and a conduction and radiation interference analysis will be made after contractual funding becomes available. LMSC has provided Hughes with model photographs that describe the LMSC array shadowing on the FRUSA array. These are now being studied to determine their effect upon the FRUSA electrical performance.

DOCUMENTATION

The FRUSA/Agena wiring diagram was completed and released. This diagram defines the electrical wiring interfaces between all FRUSA units and the Agena telemetry, command, and power subsystems. This drawing was delivered to LMSC. LMSC will fabricate the flight harness.

The Technical Plan was updated and submitted to Wright-Patterson Air Force Base.

The LMSC Interface Control Document was reviewed by Hughes, and comments and suggestions were submitted to LMSC. The document was approved on 26 June 1970 with a few exceptions that must still be resolved. The main items on which a mutual agreement is still pending pertain to electromagnetic compatibility.

FRUSA WEIGHT SUMMARY

Current system weights by individual unit are listed in Table I.

TABLE I. FRUSA FLIGHT WEIGHT SUMMARY

Item	Weight, pounds	
Solar array subsystem		70.6
Drum mechanisms	34.3	
Array panels	36.3	
Orientation mechanism subsystem		53.9
Orientation mechanism	41.9	
Control electronics unit*	12.0	
Power conditioning and storage subsystem		55.5
Battery/charge controllers	42.0	
Power conditioning unit	13.5	
Instrumentation subsystem		16.7
Accelerometers	5.0	
Solar cell electronics*	4.1	
Strain gauge amplifiers	0.8	
Instrumentation conditioning unit*	1.2	
Commutators	3.3	
Current sensors, harness, etc.	2.3	
Flexible rolled-up solar array system		196.7
Resistive load bank		35.0
Contingency		18.3
Total flight system weight		250.0

*Actual unit weight.

WORK TO BE PERFORMED NEXT QUARTER

1) Update space experiment plan

2) Update DS 30992-001 FRUSA design specification

3) Continue to analyze interfaces with Agena and respond to IWG action items

SECTION IV

SOLAR ARRAY SUBSYSTEM

SUBSYSTEM DESCRIPTION AND STATUS

The solar array subsystem consists of two flexible solar cell arrays that are stored, deployed, and retracted by the drum mechanism. The following significant items and tasks were accomplished during the eighth quarter of the program:

1) Completion of detail parts and start of assembly on the qualification model of drum mechanism

2) Continuation of fabrication of solar arrays

3) Start of full panel coverage design changes and analysis

4) Completion of tooling design for solar array subsystem assembly and test

5) Completion of tests on solar array cell groups for qualification model solar arrays

FABRICATION STATUS

Fabrication of detail parts for the qualification model of the drum mechanism has been completed. The only significant problems noted during this fabrication phase were concerned with the rolling and welding operations of the magnesium storage drum. (See Figure 2.) Some of the drum mechanism subassemblies are currently being assembled.

The etched copper/Kapton bus strips have been bonded on one of the qualification model solar arrays (Figure 2). Prior to this bonding operation, a sample sector of panel was fabricated with dummy cells and scrap pieces of bus material. (See Figure 3.) The purpose of fabricating this sample was to evaluate the untried procedures and tooling developed for the full-size panel assembly operations. Some minor problems were uncovered during the fabrication and have subsequently been corrected by tooling rework or by revisions to the procedures. Among the problems noted and solved were the following:

1) Wrinkling of Kapton substrate edges in area of lap joints

2) Wrinkling of Kapton substrate under bonded intermediate bus (located between inboard sector and drum/panel interface)

3) Improper seating of vacuum bonding fixture

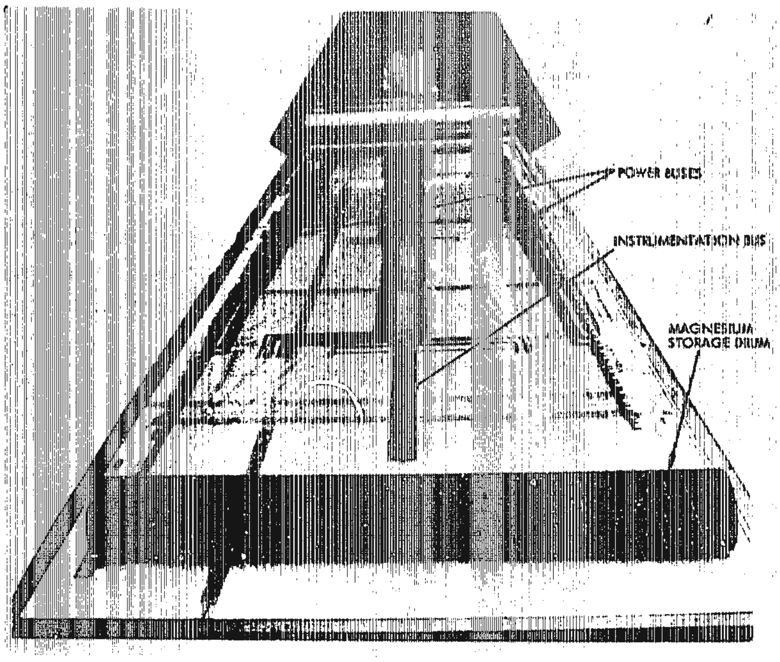

Figure 2. Qualification Model Solar Array and Storage Drum

(Photo ES28313)

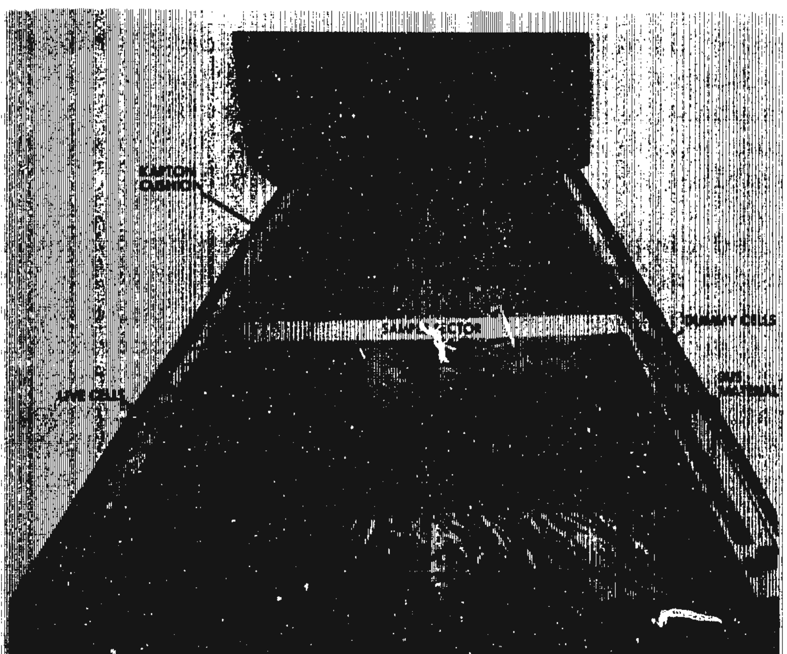

Figure 3. Qualification Model Solar Array Cushion and Sample Array Sector

(Photo ES28314)

4) Incomplete stripping of Kapton and adhesive in areas of bus material where solder joints are required

Fabrication of the new thermal shock and cycling test samples has been completed and delivered to WPAFB for testing. I-V curves were generated for these samples with the pulsed zenon solar simulator.

All 14 of the 3 x 81 cell groups for qualification model panel have been assembled and completely inspected. Test fixture and test specifications for evaluating the cell groups with the solar simulator have been prepared, and measurements with the pulsed zenon solar simulator completed.

An additional section of the fabrication specification for the solar panels has been prepared and released. This document defines in detail the assembly and wiring of live cell groups, bus strips, reference cells/modules, etc. on the panel substrate.

The assembly requirements for the drum mechanism and solar array subsystem have been prepared, reviewed, and released. The in-process test requirements section has been changed to reflect some revised test procedures. These procedures will be evaluated during the engineering test program on the qualification unit.

DESIGN AND ANALYSIS TASK

The design effort necessary to provide full live-cell coverage on the flight solar panels has been started. This change involves the replacement of dummy cells with 72 groups of 3 x 81 live cells. This will bring the total number of 3 x 81 groups on the flight panel to 142. Because of the spaces occupied by the reference cells/modules, the total number of groups is six less than the number required for providing 1500 watts at 130°F.

The procurement documentation (procurement specification, statement of work, and purchase request) for the additional 8 mil 2 x 2 cm silicon n/p flight unit cells has been prepared and placement of the order is expected in July. An analysis of the currently planned flight panel is under way. Included in the analysis are the following items:

1) I-V curves for panel at 75°, 100°, 130°, 150°, 160°, 170°, 180°, 190°, and 200°F

2) Panel power outputs for:

- 1/3 of panel at 200°F, 2/3 at 180°F*
- 1/3 of panel at 180°F, 2/3 at 170°F*
- Entire panel at 160°, 150°, and 130°F

---

*1/3 and 2/3 ratios correspond to areas covered by bus material and areas not covered by bus material, respectively.

The fixture for supporting the panels in a vertical plane during electrical tests with the solar simulator has been designed. This fixture will also be used during the panel assembly for work in areas that are difficult to reach with the panel in a horizontal position on the table. Assembly operations that will require use of this fixture include final wiring of reference cells, reference modules, and temperature sensors and rework, if required, of conventional cells located in center portion of panel. Since the fixture will be employed during the initial panel assembly operations, it will be designed to accommodate panels by themselves or attached to the drum.

Addition of the strain gauges to the boom length compensator design drawings has been completed. The study to determine optimum strain gauge wire routing concluded that a simple service loop within the tube was the best approach. Other arrangements studied proved to be too complex and/or to have a potentially undesirable effect on panel tension.

To provide a current baseline configuration to the experiment integrating contractor, all interface control drawings (ICDs) of the subsystems and units have been reviewed and upgraded. The necessary modifications were all minor changes caused by finalizing the detail designs.

PLANS FOR NEXT QUARTER

1) Completion of full-cell coverage design task

2) Preparation of current-voltage and power-voltage curves for flight panel

3) Completion of qualification model of the solar array subsystem

SECTION V

ORIENTATION SUBSYSTEM

SUMMARY

The orientation subsystem automatically maintains the solar panel normal to the sun line. It also provides signal and power transfer from the solar panel to the spacecraft and a deployment mechanism which deploys the stowed array to its normal operating configuration. The subsystem consists of essentially three subassemblies: sensor group, control electronics unit, and orientation mechanism.

Activity during this period centered on acquisition of component parts and start of assembly.

All components have been received for the orientation mechanism and sun sensor group. Assembly of some of the orientation mechanism subassem- blies has been completed, and assembly of the first mechanism is in progress. Completion of the control electronics unit has been held up awaiting some high reliability components.

Coordination meetings have been held to discuss the orientation sub- system interface with the Agena vehicle.

MECHANISM

All engineering-procured components were received by Hughes and are being used in the assembly of the mechanism.

The signal sliprings (Figure 4) were delivered with no variation from requirements. The power rings had a general problem with the wire insula- tion which tended to separate when bent too sharply. This was corrected by added local encapsulation (Figure 5).

Tachometers have been delivered per specified requirements. A basic problem was encountered in final machining of the tachometers due to the difference in properties of the copper in the commutator and the very hard encapsulating material used. A technique was worked out, wherein the copper and epoxy could be separately machined, which resolved the problem.

The drive motors possess a slightly higher resistance than required because the brush material specified exhibits a higher resistance than the standard brush material used in Inland Motors. One of the motors was tested for torque constant by taking measurements in a dry nitrogen atmosphere to eliminate the effects of moisture and found to be 20 percent low as expected from the manufacturer's data. This is not a problem since it will be com- pensated for by a 20 percent increase in motor amplifier gain in the control electronics unit.

Several EOs have been processed to take care of minor problems that occurred during component part fabrication. Most of these were in the category of minor dimensional variations. A basic problem was encountered on the magnesium housings involving the specified anodize finish. Essentially, the anodize would not permit attainment of required dimensions and finishes in mating areas, and tended to chip off. Rather than anodizing, nickel plate has been used on those areas to obtain proper dimensions and finishes. Then, some of the nickel surfaces will be painted to obtain the high thermal emittance required. Orientation mechanism housings and the drum extension arm are shown in Figure 6.

CONTROL ELECTRONICS UNIT

Fabrication of the control electronics unit (CEU) housing and circuit boards was completed during this period. Assembly of housing and circuit boards was completed; however, a few functionally equivalent commercial components were installed. These components will be replaced with the high reliability parts when they become available and prior to environmental testing.

Acceptance testing is under way and will be completed during the next period. Circuit cards are individually tested prior to testing the entire unit.

Some of the CEU hardware is shown in the following figures:

<u>Figure</u>	
7	Partial Assembly (Commutator, covers, etc. removed)
8	Partial Assembly (Commutator, covers, etc. removed)
9	Housing
10	Failure Control Circuit Card
11	Torquer Drive Circuit Card
12	Steering and Rate Shaping and Telemetry Conditioning Circuit Card
13	Front End Logic and Buffering Circuit Card

MEETINGS

Several interface meetings were held with spacecraft integrating-contractor personnel to coordinate orientation mechanism hardware and performance details. The meetings were of considerable benefit to both parties and pointed up the need for more such contacts.

Several modifications to the orientation mechanism were investigated by Hughes to determine their feasibility. The following modifications were suggested by LMSC personnel as potential aids to spacecraft operation flexibility:

1) Incorporation of a position encoder on the support axis. This involves attaching an encoded disc to the support axis housing. Accepted.

2) Rotation of the control electronics unit 180 degrees so that it is positioned under the drum axis arm rather than on the opposite side. This mod has been dropped.

3) Addition of another pair of power rings on each axis so that the current from the arrays can be split into two separate, independent paths. This mod has been dropped.

4) Changes in instrumentation and logic required to restrict the support axis rotation to 180 degrees on the side of the vehicle opposite to the LMSC fixed array. This mod has been dropped in favor of implementing a limited-rate command mode.

Mass properties data and information concerning the orientation control system have been furnished to LMSC to determine the effects of the FRUSA on the spacecraft attitude dynamics. This information includes:

a) Hysteresis in switching of tracking sensor's lockon cell, in terms of the cone-of-view angle. (None)

b) Up-to-date block diagram of CEU

c) Reaction wheel control system specification

d) Wheel control unit design specification, DS 31829-008

e) CEU specification, DS 30829-001, Rev. A

f) Source impedance for wheel command signal (5000 ohms)

PLANS FOR NEXT QUARTER

Completion of the assembly of the orientation mechanism, sun sensor group, and the control electronics unit is scheduled in the next period. Performance testing and environmental testing of the subsystem will be initiated after completion of the assembly.

Additional coordination with the spacecraft integration contractor will be undertaken as required.

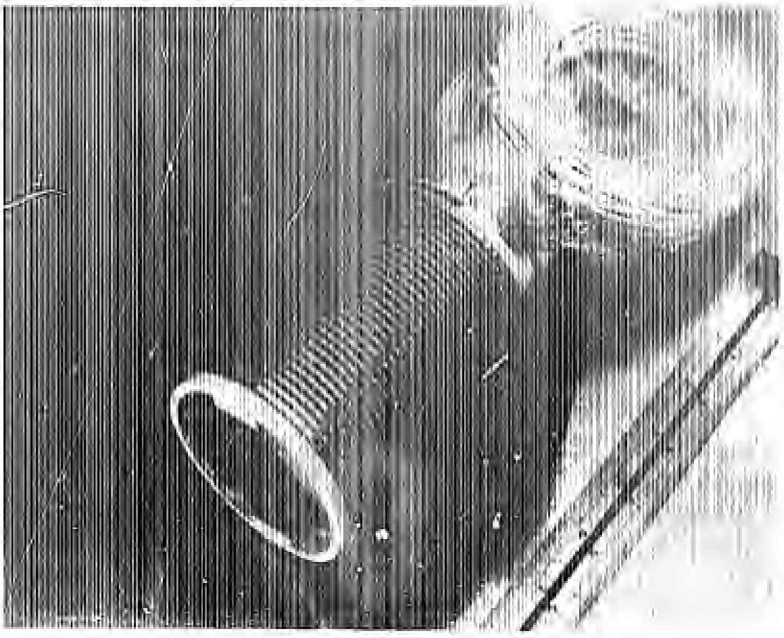

Figure 4. Orientation Subsystem Drum
Axis Data Sliprings and Brushes

(Photo ES28319)

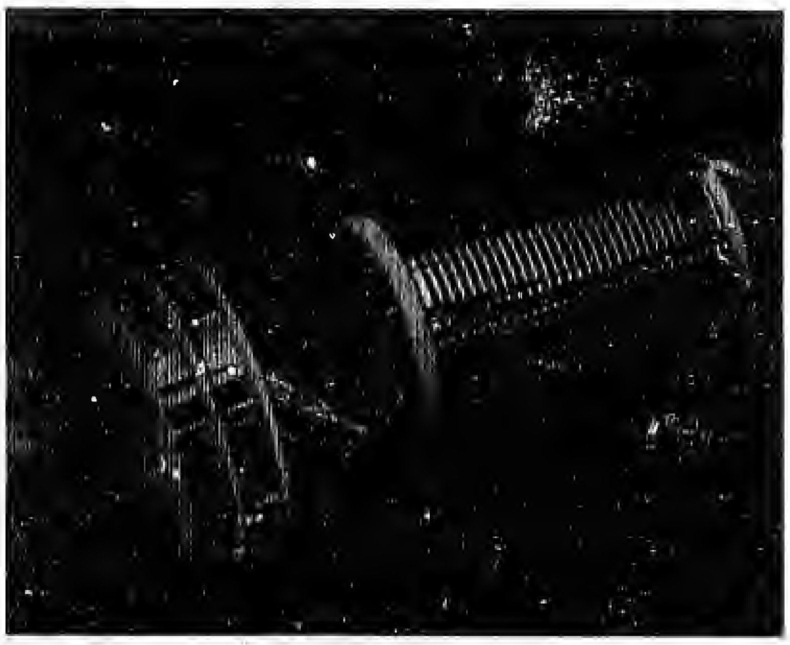

Figure 5. Orientation Subsystem Drum
Axis Power and Data Sliprings

(Photo ES28318)

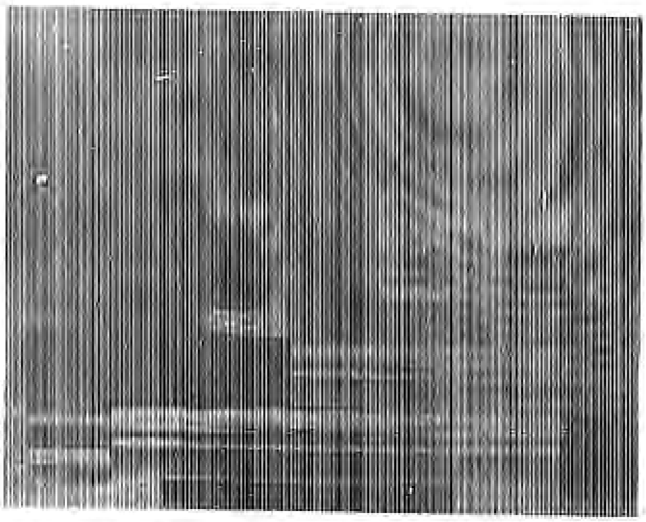

Figure 6. Orientation Subsystem
Housings and Shafts

(Photo ES28316)

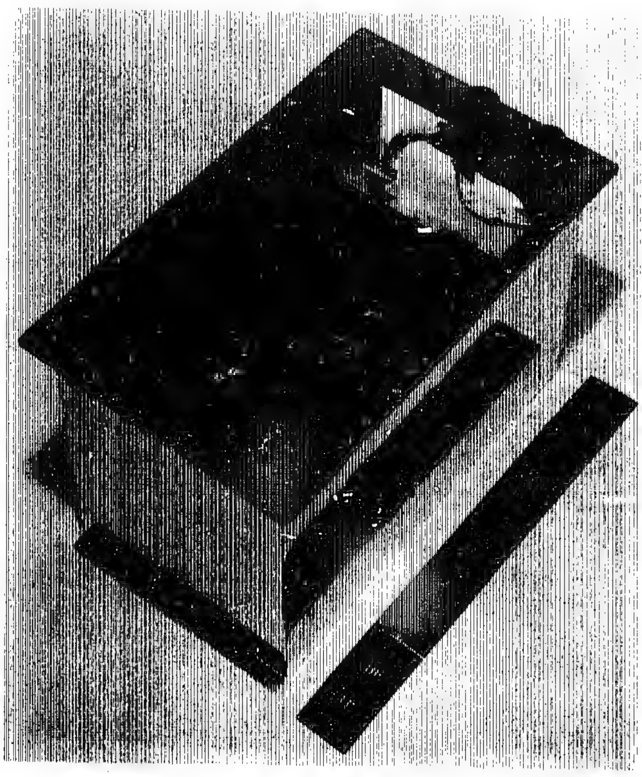

Figure 7. Partial Assembly, Control
Electronics Unit Drawing 3169042-100

(Photo 4R16393)

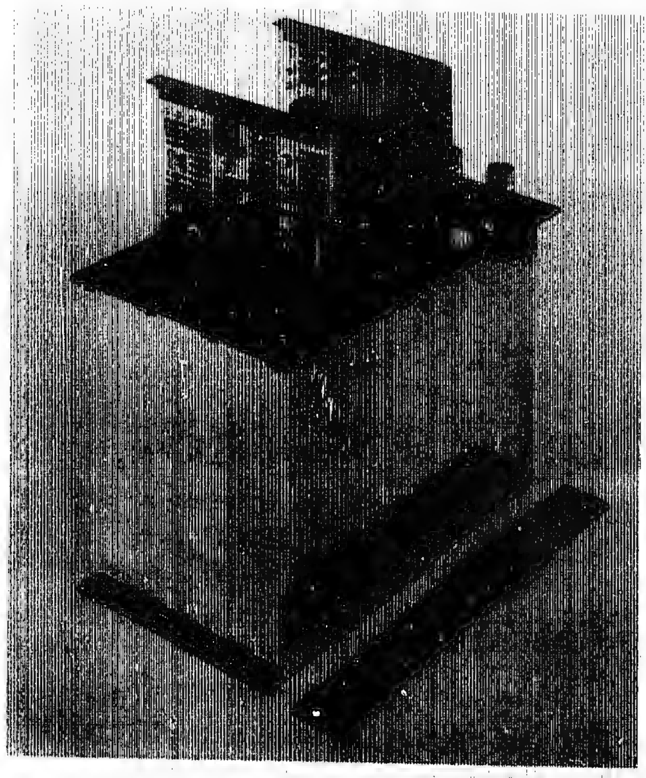

Figure 8. Partial Assembly, Control
Electronics Unit Drawing 3169042-100

(Photo 4R16392)

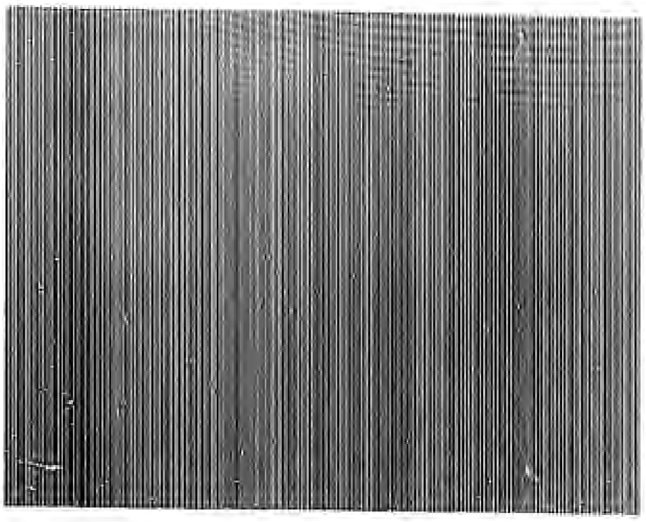

Figure 9. Control Electronics Unit Housing

(Photo 4R16394)

Figure 10. Failure Control Circuit Card, CEU Drawing 3064231

(Photo 4R16387)

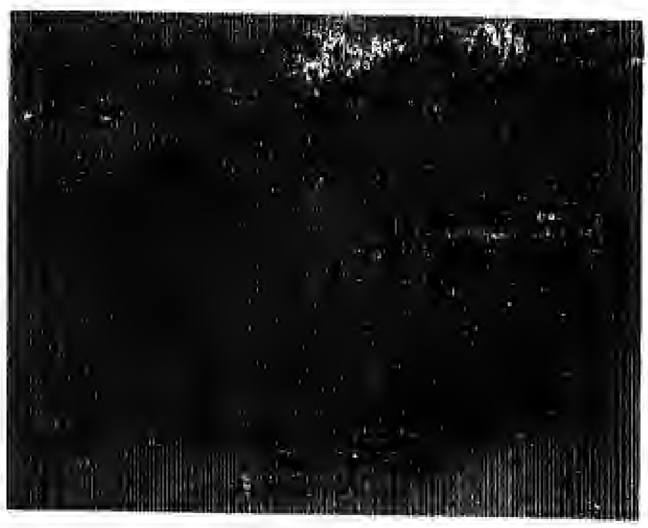

Figure 11. Torquer Drive Circuit Card, CEU Drawing 3064228

(Photo 4R16389)

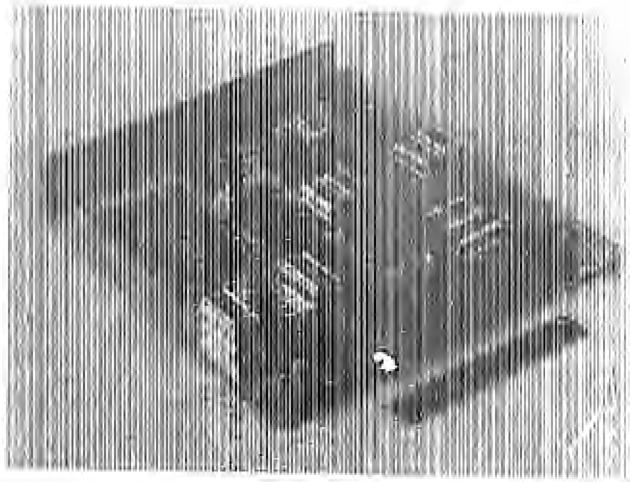

Figure 12. Steering and Rate Shaping and Telemetry Conditioning Circuit Card, Drawing 3064225

(Photo 4R16386)

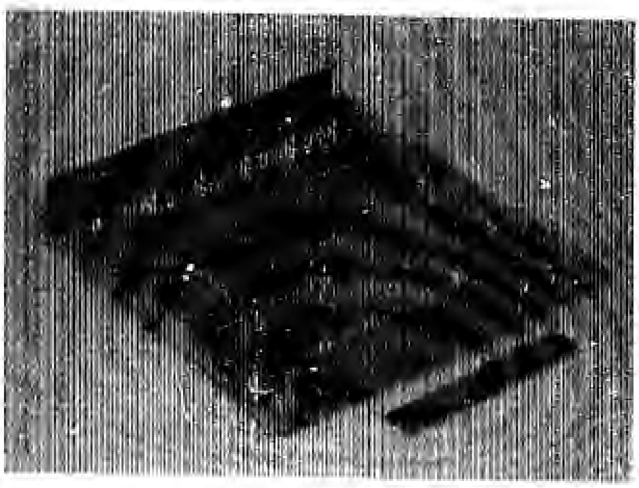

Figure 13. Front End Logic and Buffering Circuit Card, CEU Drawing 3064222

(Photo 4R16388)

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SECTION VI

POWER CONDITIONING AND STORAGE SUBSYSTEM

BATTERY/CHARGE CONTROLLER

The schematic of the battery/charge controller has been completed and released. Detail and assembly drawings have been completed and are currently being checked prior to release in early July.

POWER CONDITIONING UNIT

The schematic of the power conditioning unit has been completed and released. The detail and assembly drawings have been completed. Check of this design will begin in early July.

LOAD BANK

Analysis and design have begun on the load bank for the currently planned flight solar panels. The schematic and detail design of this unit will be completed shortly, with release scheduled for mid-July. A thermal analysis of the load bank shows that the resistors will reach 150°C in slightly over 2 minutes. The analysis was performed assuming that the resistor would hold all the heat generated. This is a conservative approach, but in the 2 minute period, very little of the heat will be removed by the chassis. The analysis will be checked experimentally if possible, but indications are that one 2 minute cycle for the load bank is reasonable since no resistor in the unit is powered more than 50 percent of the time.

BREADBOARD SUBSYSTEM TESTS

The ambient and thermal breadboard tests of the power subsystem have been completed. Several minor problems were uncovered during the test program which, after being corrected, were reevaluated by retest. During retest, all circuits performed satisfactorily over a temperature range of -25° to +185°F. Since the expected range during the mission is +14° to +140°F, the test temperatures represent approximately 30 percent margin.

BATTERY CELL PROCUREMENT

The procurement documentation for the battery cells has been released and an order for the qualification unit cells has been placed. Because of increased cell costs and program funding limitations, the following changes have been initiated:

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1) Six of the spare cells for the qualification unit battery will be used for development tests prior to the qualification test program

2) Only the qualification unit cells will be procured at this time. The split procurement is also desirable since it ensures the availability of fresh cells for the flight experiment

3) One battery/charge controller assembly will be built and employed in the qualification test program instead of two as formerly planned. This change is not expected to degrade or have any significant effect on the qualification test program.

PLANS FOR NEXT QUARTER

1) Release detail and assembly drawings of the power conditioning and storage subsystem units

2) Begin fabrication of units for qualification model

SECTION VII

INSTRUMENTATION SUBSYSTEM

SOLAR CELL ELECTRONICS UNIT (SCEU)

Fabrication and assembly of the qualification model SCEU has been completed with the exception of a few high reliability components that have not yet been delivered from the vendor. Commercial-grade parts have been temporarily installed to allow initiation of unit testing. The commercial components will be replaced by flight-qualified components prior to formal test operations. Formal testing will be completed by the end of July. The unit will then be delivered to bonded stores. The hardware is shown in Figures 14 and 15.

INSTRUMENTATION CONDITIONING UNIT (ICU)

Fabrication and assembly of the qualification model ICU has also been completed. A few commercial grade components were also used to complete the unit and will be replaced prior to formal unit testing. The ICU will be tested and delivered to bonded stores in July.

STRAIN GAUGE AMPLIFIERS

Delivery of three strain gauge amplifiers for the qualification model is expected by mid-July.

COMMUTATORS

Delivery of three PAM commutators for the qualification model, modified to be compatible with the Agena processor, is expected by mid-July.

ACCELEROMETERS

Ten ±0.1 g force balance accelerometers for the qualification model have been received.

PLANS FOR NEXT QUARTER

SCEU and ICU unit qualification tests will be completed. The units will then be shipped to bonded stores and subsequently installed on the solar array subsystem of the FRUSA qualification model.

The strain gauge amplifiers, commutators, and accelerometers will be installed on the solar array subsystem.

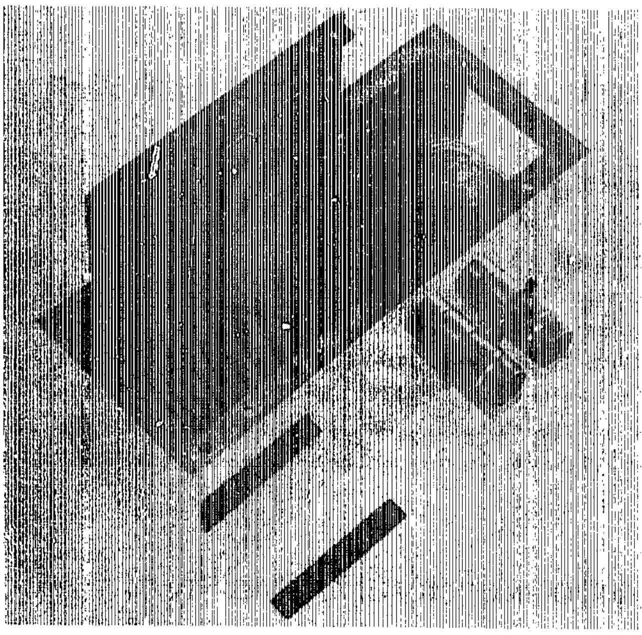

Figure 14. Partial Assembly, SCEU
Drawing 3169035-100

(Photo 4R16391)

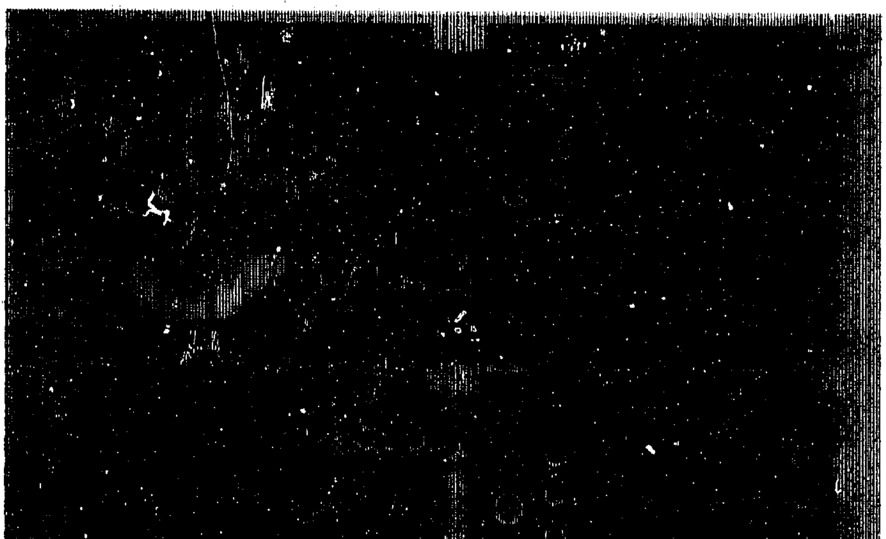

Figure 15. Printed Circuit Cards for Solar Cell Electronics Unit, Drawings (Clockwise From Upper Left): 3064258 Power Conditioning, 3064267 Current Sensing Amplifier, 3064264 Voltage Sensing Amplifier, 3064261 Timer

(Photo 4R16390)

SECTION VIII

SYSTEM TEST

SYSTEM TEST FIXTURES

A system test fixture was received from the Hughes Culver City fabrication and model shop. This fixture houses all FRUSA units including the drum mechanism which is mounted in the launch or predeployment configuration secured by brackets and pyrotechnic release mechanisms that will be provided by the integrating contractor. By applying vertical support to the outboard or aft end of the drum mechanism, gravity torques will be effectively balanced out and will allow a flight-simulated deployment test with flight-type ordnance.

A harness will be fabricated for the test fixture (similar to the flight harness) to interconnect all of the power conditioning and storage units with the orientation mechanism and allow the entire experiment to operate as an integral system.

The fixture has been set up with the water tables and a gross checkout made to check their compatibility (see Figure 16). The initial plan was to deploy the solar array from the stowed or launch configuration to a position over the water tables from where extension was to take place. This, however, is not feasible because, when the solar array is released by the pyrotechnic release mechanism, it also removes the tensile force that maintains the array in a tight rolled-up configuration and allows the booms to extend 3 to 5 inches. If the array were allowed to swing out into the operational position between the water tables, the extended booms would strike against the side of the table. It appears, therefore, that the deployment will have to be accomplished away from the tables, after which the array will be detached from the orientation mechanism and secured to a drum mechanism mounting platform fixture located between the two tables. Extension and retraction tests will then be conducted.

The design of the platform fixture for supporting the drum mechanism between the water tables is completed. Fabrication is scheduled for the next quarter. This platform will also be utilized as a handling fixture.

AGE

Preliminary requirements for the FRUSA AGE tester have been established. The primary function of the tester will be to simulate the spacecraft telemetry and command systems. It will incorporate a command generator that will apply commands to the CEU, SCEU, and the power conditioning units through test cables. It will be able to measure all PAM commutator telemetry inputs in analog form (0 to +5 volts) by connecting a test cable to each commutator connector. Power conditioning analog telemetry signals will also be available at the tester. The tester will simulate solar test cell

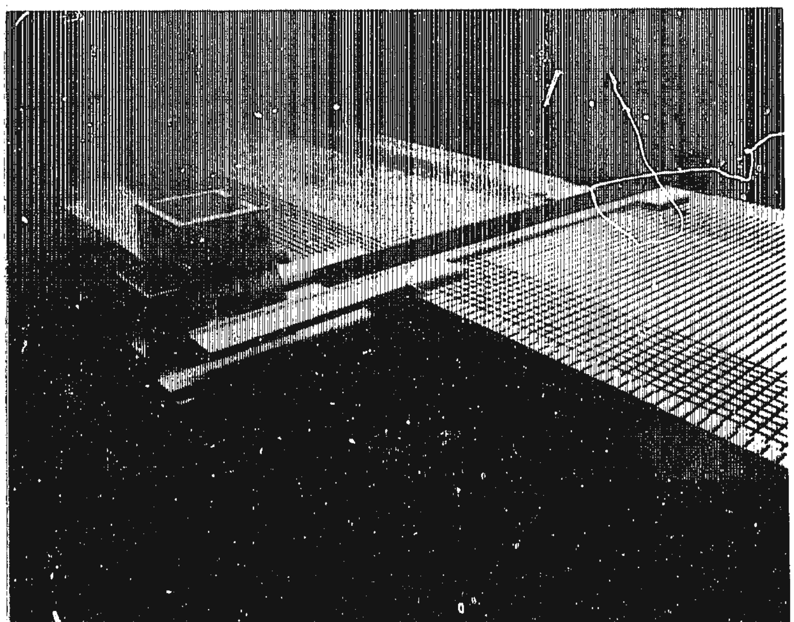

Figure 16. System Test Fixture
(Photo ES27670)

and module signals to check out SCEU operation. Word and frame timing signals, which are normally generated by the Agena PCM processor, will also be generated by the tester.

The FRUSA AGE tester, plus a 10 ampere 20 to 44 volt solar simulator supply, will be shipped with the FRUSA experiment to LMSC and the launch site to perform functional checkouts of the experiment, as required, independent of the Agena telemetry, command, and power subsystems.

The FRUSA AGE tester (with its ancillary power supply) will also be used at Hughes during the system test program. In addition to the FRUSA tester, the following equipment is required to perform the detail testing that is planned: a magnetic tape recorder, PAM decommutator, a six-channel brush recorder, a time code generator, several small digital voltmeters, and an oscilloscope. All of this test equipment will be mounted in a standard 19 inch rack.

Telemetry data streams from the three FRUSA commutators will be recorded on magnetic tape during Hughes system tests for subsequent data reduction. The 24 power conditioning telemetry signals are commutated in the tester (with a commutator similar to that used in the FRUSA equipment) and also recorded on tape.

The PAM decommutator will convert the digital data streams from the four commutators into analog signals and provide simultaneous readout of approximately ten telemetry signals.

A 60 ampere, 20 to 44 volt supply will be required to check out the power cabling, sliprings, solar array current shunts, and load bank assembly. This supply will be provided by Hughes for testing at Hughes. A similar supply will be provided by LMSC for spacecraft integration testing.

DOCUMENTATION

The FRUSA qualification test plan has been completed. It describes all system level testing that will be conducted under ambient, vibration, and solar thermal-vacuum conditions.

PLANS FOR NEXT QUARTER

1) Design and fabricate vibration test fixtures

2) Design and fabricate FRUSA tester

3) Assemble system test ancillary equipment into a test rack

4) Write system test procedures for qualification testing

5) Fabricate mounting and handling fixture for drum mechanism

6) Optimize overhead camera installation for water tables

SECTION IX

RELIABILITY

Fifteen log books have been distributed, one for each unit, in which the results of tests and any other pertinent information regarding the particular unit will be entered by the unit engineer. These books together with the Quality Control History Record will form a complete history of the unit from its inception to delivery.

The preferred parts list has been revised to include a number of high reliability military parts; these are the established reliability (ER) passive components and test extra (TX) semiconductors. These parts are readily available from local distributors in the small quantity required for this program.

All electronic parts for the qualification model are being inspected in the Receiving Inspection Department. Inspection is to specified electrical parameters, count and damage.

Inspection of the solar panel and electronic unit fabrication is continuing.

PLANS FOR NEXT QUARTER

1) Source surveillance of high reliability to parts

2) Incoming inspection of parts

3) Inspection of qualification model components

4) Fabrication inspection

5) Initiation of TFR system

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13. ABSTRACT

The main activities on the Flexible Rolled-Up Solar Array (FRUSA) during the eighth quarterly reporting period consisted of completion of detail parts and start of assembly of the development/qualification model orientation mechanism and solar array.

The panel substrate and bus assembly is nearing completion and solar cell bonding will begin the second week in July. Assembly of some of the orientation mechanism subassemblies has been completed, and the assembly should be complete by 1 August. Fabrication of the control electronics unit, solar cell electronics unit, and instrumentation conditioning unit has been completed. However, the late delivery of some high reliability components has necessitated the utilization of a few functionally equivalent commercial components so that acceptance testing of the units could be started. The commercial components will be replaced with the high reliability parts when they become available and, in any event, prior to environmental testing. Schematics and detail and assembly drawings of the battery/charge controller and power conditioning units have been completed. Schematics of the load bank have been completed. Detail design is nearing completion. Release of drawings of all three units is scheduled for mid-July. Procurement of high reliability parts for the units has been initiated. ()

Several working group meetings were held between SAMSO/Aerospace/LMSC and Hughes to resolve interface problems, the most serious of which seems to be the shading of the FRUSA panels by the LMSC rigid array. The change directed by the customer to provide full live-cell panel coverage and to incorporate a position encoder, furnished by LMSC, on the orientation mechanism support axis has been implemented in the design.

The FRUSA/Agena wiring diagram was completed and released. The Technical Plan was updated and submitted to WPAFB.

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